

**EXPLORING TRANSFORMATIONS of QUADRATIC FUNCTIONS****Transformations:**

Operations performed on functions to change the position or shape of the associated curves or lines.

*A quadratic function in VERTEX FORM is represented by:*

$$y = a(x-h)^2 + k$$

**ACTIVITY:** How do the parameters  $a$ ,  $h$ , and  $k$  in a quadratic function in vertex form change the graph of  $f(x) = x^2$ ?

Using a graphing calculator, graph the quadratic functions shown in the table on the same set of axes. Complete the table for each function.

Part I

	Function	Value of $k$ in $f(x) = x^2 + k$	Direction of Opening	Vertex	Axis of Symmetry	Congruent to $f(x) = x^2$ ?
a)	$f(x) = x^2$	0	up	(0, 0)	$x = 0$	yes
b)	$f(x) = x^2 + 2$	2	up	0, 2	$x = 0$	yes
c)	$f(x) = x^2 + 4$	4	up	0, 4	$x = 0$	yes.
d)	$f(x) = x^2 - 1$	-1	up	0, -1	$x = 0$	yes
e)	$f(x) = x^2 - 3$	-3	up	0, -3	$x = 0$	yes.

What happens to the graph of the function  $f(x) = x^2 + k$  when:

- $k$  is a positive value?

graph of  $y = x^2$  moves up by  $k$

- $k$  is a negative value?

graph of  $y = x^2$  moves down by  $k$

What happens to the points on  $f(x) = x^2$  when the function is changed to  $f(x) = x^2 + k$ ?

x-coordinates: no change

y-coordinates: add/subtract each y-coordinate by a value of  $k$

Part II

	Function	Value of $h$ in $f(x) = (x - h)^2$	Direction of Opening	Vertex	Axis of Symmetry	Congruent to $f(x) = x^2$ ?
a)	$f(x) = x^2$	0	up	(0, 0)	$x = 0$	yes
b)	$f(x) = (x - 2)^2$	2	up	2, 0	$x = 2$	yes
c)	$f(x) = (x - 4)^2$	4	up	4, 0	$x = 4$	yes
d)	$f(x) = (x + 2)^2$	-2	up	-2, 0	$x = -2$	yes
e)	$f(x) = (x + 4)^2$	-4	up	-4, 0	$x = -4$	yes.

$$y = a(x - h)^2 + k$$

What happens to the graph of the function  $f(x) = (x - h)^2$  when:

- $h$  is a positive value?

graph moves to the right  $h$  amount

- $h$  is a negative value?

graph moves to the left  $h$  amount

What happens to the points on  $f(x) = x^2$  when the function is changed to  $f(x) = (x - h)^2$ ?

x-coordinates:

move left/right by value of  $h$

y-coordinates:

no change

Part III

	Function	Value of a in $f(x) = ax^2$	Direction of Opening	Vertex	Axis of Symmetry	Congruent to $f(x) = x^2$ ?
a)	$f(x) = x^2$	1	up	(0, 0)	$x = 0$	yes
b)	$f(x) = 2x^2$	2	up	0,0	$x=0$	no
c)	$f(x) = 0.5x^2$	0.5	up	0,0	$x=0$	no
d)	$f(x) = -2x^2$	-2	down	0,0	$x=0$	no
e)	$f(x) = -0.5x^2$	-0.5	down	0,0	$x=0$	no

What happens to the graph of the function  $f(x) = ax^2$  when:

- $a$  is a positive value?

opens up

- $a$  is a negative value?

opens down

$a < 1$  greater than / narrow / stretched  
 $0 < a < 1$

compressed / wider

What happens to the points on  $f(x) = x^2$  when the function is changed to  $f(x) = ax^2$ ?

x-coordinates:

no change when  $a > 1$ , or  $0 < a < 1$ , or  $a < 0$

y-coordinates:

when  $a > 1$ , y values are multiplied by  $a$   
 when  $0 < a < 1$ , y values are multiplied by  $a$   
 when  $a < 0$ , y values are multiplied by  $a$